Real-Time Structural Damage Study Using ARMarkov Observers

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ARMarkov model based observers are applied for real-time Structural Health Monitoring (SHM). Aim of the study is to evaluate the feasibility of using predesigned set of ARMarkov observers for real-time structural health monitoring. ARMarkov observers are applied to estimate the extent of damage in a member and to track further changes in the stiffness of the damaged member in real-time.

ARMarkov observes are based on interaction matrix formulation. Importance of interaction matrix formulation is evident for real-time structural health monitoring when exact initial conditions are not available. ARMarkov observer based real-time structural damage detection method works well, in the case of either a full set or a limited number of available measurements. Sensitivity to the structural damage can be enhanced by incorporating feedback control gain algorithms into the proposed method. ARMarkov observer based method distinguish between the errors due to structural damage and due to noise in output measurements.

Numerical simulations on a three DOF mass-spring-damper system are presented. Effects of initial conditions die out very fast due to interaction matrix formulation, thus ARMarkov observer is able to capture time instants during which damage has occurred. It is shown that ARMarkov observers can be applied for structural health monitoring for damages in several members at different time instants. Pole placement technique is successfully applied to enhance the sensitivity of the structural damage. It is shown that amplification of error due to noise is evident once structural damage occurs and can be easily distinguished. Numerical simulations on a planar truss structure validates the proposed method. Predefined ARMarkov observers are applied to estimate the extent of damage and to track the stiffness variation in a damaged member of a planar truss using only a limited number of output measurements.

It is shown that it is possible to estimate the extent of damage in a member and track the stiffness of the damaged member using ARMarkov observers. The number of ARMarkov observers depends upon the accuracy with which the stiffness of the damaged member needs to be determined and noise levels in output measurements. Although the proposed method has the aforementioned advantages over existing observer based methods, it suffers from the limitation of observer based methods that it needs a large bank of ARMarkov observers for multiple damage cases.

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